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ON THE BRECCIATED CHARACTER OF THE ST. LOUIS LIMESTONE.

BY C. H. GORDON.

IN the absence of the Chester, the St. Louis beds constitute the uppermost division of the Subcarboniferous in Iowa. They consist generally of limestone above, yellowish-gray, more or less magnesian layers below, with a light gray friable sandstone between. The character of the limestone constituting the uppermost division is such as to merit more than a passing notice.

Throughout its area in Iowa, and its northern outcrop in Illinois, it has a peculiar brecciated or concretionary structure, not observed elsewhere. It is made up of a mass of angular limestone fragments, which have become more or less firmly recemented together. The stratification is very irregular, though in some places, where the brecciated character is absent, it is found even enough to furnish very excellent building stone. It is generally hard, and often cherty, and where it forms the floor to the coal measures, constitues a very excellent guide to those in search of this useful deposit. Its cherty character makes it very difficult to penetrate, and so when once reached it is readily recognized. In its typical locality—at and about St. Louis, where it was first studied by Dr. Shumard—it is described as a fine-grained, compact, subcrystalline limestone, often enclosing numerous cherty concretions, and the layers separated by thin

green shale beds. It thus appears that the lithological character of these beds changes toward the south.

The question as to the cause of the peculiar brecciated character of the limestone in Iowa and adjacent parts of Illinois presents a pertinent field of inquiry. Worthen and Hall make frequent mention of this feature of the St. Louis limestone, and White goes so far as to say that "during the time of the deposition of this limestone there seems to have been some slight disturbance of the strata, apparently amounting only to local disarrangements of its own layers. This is principally shown in the upper division, and consists of the slipping, bending or slight distortion of all the strata, also by the breaking up of that limestone into angular fragments which have in many cases become recemented together by similar limestone material, forming the breccia above referred to. The most of the disturbance seems to have prevailed during the deposition of the upper division." [1] It would be exceedingly interesting to learn the nature of these local disturbances. Hall speaks of it as follows: It "consists generally of a breccia composed of fine, compact, ash-colored limestone in fragments of various sizes, having the interstices filled with a subcrystalline, yellowish, granular, calcareous material, which is sometimes quite pulverulent, and rarely very compact. The rock at Keokuk, and at points above this on the river, as well as at Mt. Pleasant and elsewhere, appears like the attenuated margin of a more important formation, presenting the usual fractures of the thinning out of a limestone, viz., a brecciated and concretionary structure. This presumption proves to be true, for as we trace the rock southward beyond the state, it presents other aspects, gradually losing its concretionary and brecciated character, and becoming a more important limestone formation." [2]

This explanation can hardly be considered adequate, for it would necessarily follow that the attenuated margins of all limestones should present the same characteristics; whereas they do not. That the brecciated character is a marginal attendant in

[1] Geological Survey of Iowa 1870, Vol. I., p. 218.

[2] Geological Survey Iowa, 1858, Vol. I., Part I, p. 98.

this case cannot be gainsaid; but that the shore line is always thus attended cannot be sustained by facts. The stress laid upon this feature of the St. Louis limestone by Worthen, White, and even Hall himself, is of itself sufficient to necessitate an additional explanation of its cause.

Another important feature of this limestone not yet noted, and one of great significance, is its oölitic character. In the Iowa Reports this is not mentioned by White, though noted several times in the detailed observations by Prof. Worthen in Hall's Report of 1858, as also in the Illinois Reports.

"Above it becomes a regularly bedded light gray limestone, in strata from six to twenty inches in thickness, the upper layers having an oölitic structure."[3] In the vicinity of Keokuk, Iowa, the semi-oölitic character may also be observed, though not especially prominent.

In Illinois it was observed by Worthen at several localities: "Oölitic beds are quite characteristic of this division, and in Hardin county massive beds of oölitic limestone form the upper portion of it at several localities. . . . . About three miles above Alton there are some oölitic and semi-oölitic beds in the lower part of the division, which are characterized by great numbers of small shells."[4]

In Indiana the oölitic structure is especially prominent, occurring in massive strata twenty to thirty or more feet in thickness in the counties of Owen, Monroe, Lawrence, Washington, Harrison, and Crawford.

The quarries in these counties supply a most excellent building stone, which is becoming quite celebrated for its durability, as well as the facility with which it may be dressed to any desired form.

It "has been formed from the crushed remains of marine shells, corals, etc. These have been pulverized to the condition of fine sand, their soluble impurities washed away, and their insoluble residue reunited into solid rock by a deposit of carbonate of lime as a cementing material. . . . . Its rich gray color, close

[3] At Croton, Ia. Hall's Report, 1858, p. 191.

[4] Illinois Report, Vol. I., p. 88.

and uniform texture, and facility of working, both by hand and machinery, make it extremely valuable for architectural purposes, and its assured strength and durability make it especially desirable for all permanent engineering works." [5]

Another notable feature of this limestone, especially in Iowa, is its irregularity as to thickness: frequently varying from ten to fifty feet within very short distances. At Keokuk the thickness is from ten to twenty feet; following up the Des Moines river, the course of which is nearly parallel with its original outcrop, its thickness increases until we reach Farmington, where it measures seventy-five feet. Between this place and Bentonsport, thirteen miles beyond, it decreases to four or six feet. This irregularity in thickness is accompanied by trough or basin-like depressions in the surface of the limestone, in which the coal measures were afterward deposited. A miniature basin of this kind occurs at Hillsborough, while at Farmington the coal occurs in a more extensive depression. At Hillsborough the basin is "oval in form, and does not exceed fifty paces in diameter in either direction. The coal dips rapidly from the edge to the centre, where it is about fifteen feet below the surface of the limestone, outcropping around the rim of the basin." [6] Fig. 1, Plate X., shows a cross-section of this basin:

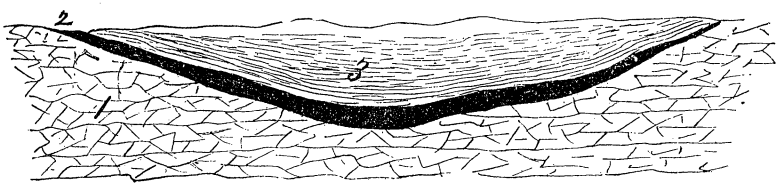
We have observed the same irregularity in the surface of this limestone at Keokuk, the thickness at one place being diminished by half in a distance of one hundred feet. The accompanying section across Point Keokuk from northeast to southwest (Fig. 2, Plate X.,) shows the observed position of these beds.

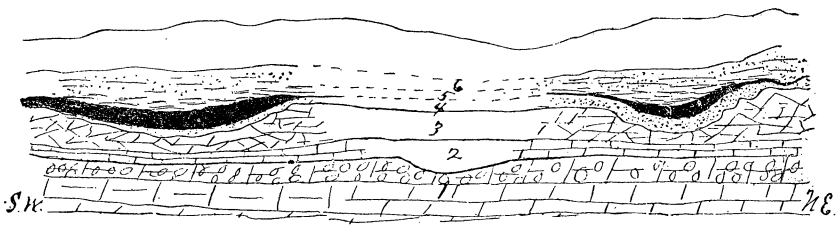
Toward the northeast the junction of the sandstone with the limestone may be observed, showing very conclusively the uneven surface of the limestone, and, a few inches above, a black coaly layer, here amounting to a mere parting, but which rapidly thickens to a layer ten or twelve inches in thickness, accompanied by a still greater thickness of slate. This basin is apparently a very small one. Within the limits of the city these rocks have been mostly removed by erosion. A similar basin occurs toward

[5] Indiana Report, 1881., p. 29, et seq.

[6] Hall's Iowa Report. Vol. I., Part I., p. 223.

PLATE X.





THE ST. LOUIS LIMESTONE.

the south, but we have not observed the underlying sandstone. Here the coal is found eighteen to twenty inches thick.

The facts above cited would seem to warrant certain conclusions as to the conditions under which the limestone was deposited. Its general character would seem to imply the existence of coral reefs fringing the shore throughout its northern extent. The accompanying map (Plate XI.) shows approximately the expanse of the Gulf during the St. Louis epoch.

The probable direction of the Gulf Stream is indicated by the arrows. The proof of the existence of marine currents and clear waters along the borders in Iowa, Illinois, Indiana, and southward, lies in the presence at these points of extemsive beds of limestone. It would seem improbable that any communication with the ocean existed to the north and east, for had such existed the Gulf Stream would, doubtless, have taken that direction, involving clear waters and limestone deposits; whereas, the arenaceous and argillaceous characters of the Lower Carboniferous of Ohio are marked. The northern extension of the Gulf Stream, bringing with it the warm waters of the Tropics, would materially affect the climate of this region, and in part explain the tropical conditions during the following epoch.

The causes operating to exclude corals from tropical coasts, as shown by Dana,[7] are: (1) cold extratropical ocean currents; (2) muddy, or alluvial shores, or the emptying of large rivers; (3) presence of volcanic action; (4) depth of water on precipitous shores. The first and third were manifestly absent. That the shores were not muddy is shown by the presence of the limestone as noted above.

The general dip of the strata here is toward the south and west. It is very slight, but increases along the Mississippi, after leaving the lower line; it changes, however, so as to bring the Lower Carboniferous again to the surface in the region of Quincy, Ill.

There is thus afforded just such a shelving shore as would comport with required conditions.

It is therefore not at all improbable that a line of reefs occupied

[7] Manual, p. 617.

this northern shore line, just as Florida is now fringed by its existing representative.

This conclusion is strengthened by the resemblance of the St. Louis limestone to coral rocks. Dana[8] describes coral rocks as: (1) fine-grained, compact, clinking limestone, with or without fossils; (2) a compact oölite; (3) a conglomerate, mostly of corals and shells; (4) a rock consisting of corals as they grew,—the interstices filled in with coral sand, shells, and fragments, sometimes very loosely. By the incessant trituration of the waves the original features of coral rocks are to a great degree lost, and the oölitic and brecciated characters are the most prominent remaining features.

From Le Conte[9] we learn that "in some places . . . . it (coral rock) is a coarse conglomerate or *breccia*, composed of fragments of all sizes cemented together; in other places it is made up entirely of rounded granules of coralline limestone (coral sand) cemented together, and forming a peculiar oölitic rock. But the larger portion of the reef ground is a fine, compact limestone, made up of comminuted coralline matter (coral mud) cemented together. This fine coral mud is carried by waves and tides into the lagoon and serves to raise its bottom; it is also carried by currents and distributed widely over the neighboring sea bottoms. . . . . In some places it (reef rock) contains imbedded remains of corals and shells, but in other parts it is entirely destitute of these remains."

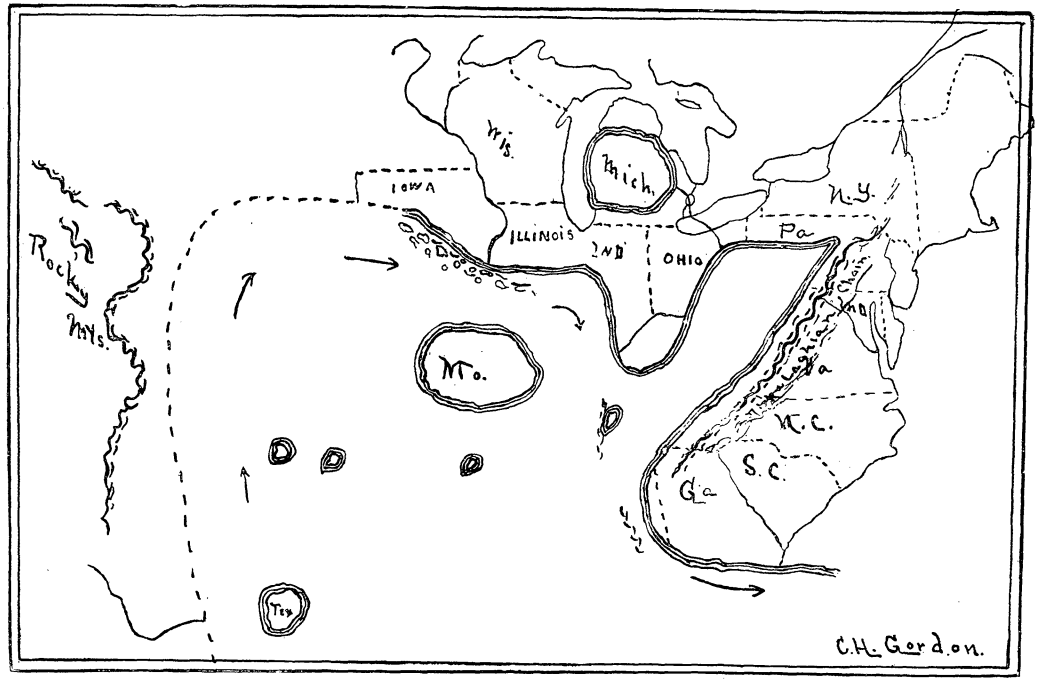
The corroborative evidences of a like origin for the St. Louis limestone may be briefly summarized as follows:

1. In its brecciated character and uneven stratification it closely resembles the brecciated portions of coral rock now forming. In general the fragments are composed of fine-grained bluish-gray limestone, resembling the clinking limestone of the coral seas. The only coral generally distributed through it is the massive *Lithostrotion canadense* Castelnau, the remains of which are abundant and conspicuous. The remains of this fossil occur at numerous localities in Iowa, Missouri, Illinois, Indiana,

[8] Manual, p. 620.

[9] Elements, p. 148.

PLATE XI.



THE CARBONIFEROUS OCEAN AND CONTINENT.

Kentucky, Tennessee, and Alabama. "This fossil is one of the most widely distributed corals of the Carboniferous limestones, and appears to hold the same geological position from Central Iowa to Alabama, everywhere marking the horizon of the St. Louis limestone." [10] In Iowa both the fossiliferous and unfossiliferons kinds of rock may be observed in the regions of the brecciated limestone. In some cases masses of the coral are found unbroken, but usually they are in a fragmental condition. In the vicinity of Keokuk we have observed places at which the limestone pieces are conspicuously fossiliferous, abounding in broken fragments of the above coral, as well as other fossils in a more or less comminuted condition. On the whole, however, the brecciated portions are comparatively unproductive of fossils. It is significant that n its extension northeastward into Ohio and Pennsylvania no remains of *L. canadense* are found, though Meek has shown this formation to be present in that region.

2. The character of the St. Louis towards the south corresponds with what might be expected in its more seaward portions It there becomes more evenly stratified and greatly more fossiliferous. The brecciated character is nearly lost, appears only at intervals, beginning and ending abruptly, and the intermediate portions showing more or less oblique laminations.

4. The uneven surface of the brecciated limestone would be a necessary sequence of the development of land seaward along a reef-bound coast.

On the retreat of the sea the lagoons and intermediate spaces were filled by shore-wash, accompanied by a luxuriant vegetation, and land progression outward, similar to that of Florida, as shown by Agassiz, in more recent times. Under this hypothesis the irregular pockets and basins of coal in the Lower Coal Measures are easily accounted for. They result from the accumulation within the lagoon of vegetation growing upon the banks or transported from without. That in these cases it did not in all cases grow in situ would appear from the fact that the coal rests almost immediately upon the limestone with no intervening layer to form a soil for its growth. In other localities the coal is under-

[10] Hall. Geology Iowa, Vol. I., Part II., p. 668.

laid by a stratum of soft, coarse sandstone. In this connection it might be objected that the above explanation would make the deposit of sandstone contemporaneous with the growth of some portions of the coral reef, in which case it should contain some internal proof of proximal relations. Such proof is not wanting. On the Iowa side of the Mississippi river, one-half mile above Keokuk, the brecciated limestone is overlaid by fifteen feet of this sandstone, which is somewhat harder than usual elsewhere, forming a projecting ledge. At this locality the writer has observed a mass of *Lithostrotion canadense* five or six inches in diameter imbedded in the lower portions of the sandstone, about two feet above the base. The presence of the coral here is accounted for on the supposition that at some not distant point a coral reef was growing at the time this sandstone was deposited. By the action of the waves this mass was broken from its bed and driven along the shallow bottom to find at last a resting-place in the mud and detritus brought in from the neighboring land. That the distance may not have been great may be inferred from the known fact that in coral regions the transition from a bottom of coral detritus to one of mud or earth is often very abrupt.[11]

From the above we submit the following brief

RECAPITULATION:

1. The Upper Division of the St. Louis Beds is a limestone which in its northern extension is decidedly brecciated and irregular in stratification and thickness. In the interior, with a few exceptions apparently due to littoral conditions, the rock is of a fine-grained, even texture, and regular stratification.

2. No adequate cause for this prominent feature of the limestone has thus far been advanced. While present in the attenuated margins of some limestones, it is not in all, and hence would imply the existence of other than littoral conditions alone.

3. Another significant feature accompanying the brecciated structure of this limestone is its oölitic character.

[11] Dana, Manual, p. 623.

4. In these and other features the limestone shows marked resemblances to that observed in coral regions.

5. The conditions for the growth of reef-building corals were apparently present at the time of the deposition of the St. Louis Beds. That the *Lithostrotion canadense* and *L. proliferum* were reef-building corals seems quite probable, though scarcely susceptible of proof.

6. The presence of coral reefs along the shore-line during the St. Louis epoch would seem to account for the various peculiarities of structure and arrangement observed in this limestone.

Keokuk, Ia., March, 1890.

THE HISTORY OF GARDEN VEGETABLES.

BY E. L. STURTEVANT.

(Continued from p. 157, Vol. XXIV., 1890.)

PORTUGAL CABBAGE. *Brassica oleracea costata* D.C.

THIS cabbage is easily recognizable through the great expansion of the midribs and veins of the leaf, in some cases forming quite half of the leaf, and the midrib losing its identity in the multitude of radiating branching veins. In some plants the petioles are winged clear to the base. Nearly all the names applied to this form indicate its distribution, at least in late years, from Portugal, from whence it reached English gardens about 1821,[1] and in American gardens, under the name of Portugal Cabbage, about 1850.[2] It should be remarked, however, that a *Choux a la grosse cote* was in French gardens in 1612,[3] and in three varieties in 1824.[4]

[1] Hort. Soc. Trans., 1821, 12.

[2] Buist. Fam. Kitch. Gar., 1851.

[3] Le Jard. Solit., 1612, 158.

[4] L'Hort. Franc., 1824.